Complete Summary

GUIDELINE TITLE

Care of the patient with aneurysmal subarachnoid hemorrhage.

BIBLIOGRAPHIC SOURCE(S)

American Association of Neuroscience Nurses. Care of the patient with aneurysmal subarachnoid hemorrhage. Glenview (IL): American Association of Neuroscience Nurses; 2007. 30 p. [140 references]

GUIDELINE STATUS

This is the current release of the guideline.

** REGULATORY ALERT **

FDA WARNING/REGULATORY ALERT

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- December 16, 2008 - Antiepileptic drugs: The U.S. Food and Drug Administration (FDA) has completed its analysis of reports of suicidality (suicidal behavior or ideation [thoughts]) from placebo-controlled clinical trials of drugs used to treat epilepsy, psychiatric disorders, and other conditions. Based on the outcome of this review, FDA is requiring that all manufacturers of drugs in this class include a Warning in their labeling and develop a Medication Guide to be provided to patients prescribed these drugs to inform them of the risks of suicidal thoughts or actions. FDA expects that the increased risk of suicidality is shared by all antiepileptic drugs and anticipates that the class labeling change will be applied broadly.
- December 3, 2008 - Innohep (tinzaparin): The U.S. Food and Drug Administration (FDA) has requested that the labeling for Innohep be revised to better describe overall study results which suggest that, when compared to unfractionated heparin, Innohep increases the risk of death for elderly patients (i.e., 70 years of age and older) with renal insufficiency. Healthcare professionals should consider the use of alternative treatments to Innohep when treating elderly patients over 70 years of age with renal insufficiency and deep vein thrombosis (DVT), pulmonary embolism (PE), or both.

COMPLETE SUMMARY CONTENT

SCOPE

DISEASE/CONDITION(S)

Aneurysmal subarachnoid hemorrhage

GUIDELINE CATEGORY

Diagnosis
Evaluation
Management
Screening
Treatment

CLINICAL SPECIALTY

Critical Care
Emergency Medicine
Internal Medicine
Neurological Surgery
Neurology
Nursing
Pediatrics
Physical Medicine and Rehabilitation

INTENDED USERS

Advanced Practice Nurses
Health Care Providers
Hospitals
Nurses

GUIDELINE OBJECTIVE(S)

- To assist registered nurses, patient care units, and institutions in providing safe and effective care to patients recovering from aneurysmal subarachnoid hemorrhage
- To provide background on the biological processes occurring during and after rupture of a cerebral aneurysm and provide evidence-based guidelines for providing nursing care to this population

TARGET POPULATION

Children and adults with suspected or known aneurysmal subarachnoid hemorrhage

INTERVENTIONS AND PRACTICES CONSIDERED

Evaluation/Assessment (Pre- and Post-Aneurysm Securement)

1. Neurologic assessments, including level of consciousness, cranial nerve assessment, and motor exam
2. National Institutes of Health Stroke scale scoring
3. Glasgow Coma Scale scoring
4. Vital signs assessment
5. Laboratory data collection
    - Basic metabolic chemistry and electrolytes
    - Cardiac troponins, creatine phosphokinase isoenzymes
    - Coagulation studies
    - Complete blood count, type, and screen
    - Urine toxicology and chemistry
    - Arterial blood gases
    - Anticonvulsant levels
6. Chest x-ray
7. Echocardiography
8. Intracranial pressure monitoring
9. Transcranial Doppler ultrasonography
10. Cerebral angiography
11. Electroencephalography
12. Computed tomography
13. Cardiovascular monitoring (hemodynamics, central venous pressure, pulmonary artery pressure)
14. Respiratory monitoring (blood gases, pulse oximetry, end tidal carbon dioxide)
15. Renal assessment (urine output, urine electrolytes and specific gravity)
16. Gastrointestinal (abdominal) assessment
17. Skin assessment
18. Endocrine assessment (blood glucose)
19. Psychosocial assessment

Treatment and Management: Pre- and Postaneurysm Securement

1. Intubation and mechanical ventilation
2. Cerebrospinal fluid drainage to control intracranial pressure
3. Blood pressure management
4. Fever management
5. Intravenous fluids
6. Parenteral or enteral nutrition with tight glycemic control
7. Activity limitation
8. Deep venous thrombosis prophylaxis
9. Seizure prophylaxis (anticonvulsants)
10. Stool softeners
11. Pain management

12. Sedatives
13. Antiemetics
14. Cerebral edema treatment
15. Calcium channel blockers (nimodipine) for prevention and treatment of cerebral vasospasm
16. Gastrointestinal hemorrhage prophylaxis
17. Psychosocial considerations
18. Patient and family education
19. Screening of family member based on physician preference
20. Documentation

MAJOR OUTCOMES CONSIDERED

- Incidence and types of secondary injury to aneurysmal subarachnoid hemorrhage
- Disability
- Mortality
- Duration of intensive care unit admission
- Duration of hospitalization
- Time to maximum recovery

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Hand-searches of Published Literature (Secondary Sources)
Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

A review of the published literature from January 1982 to November 2006 was conducted using Medline/PubMed, CINAHL, and Evidence-Based Medicine Reviews using the following search terms: *subarachnoid hemorrhage*, *cerebral vasospasm*, *management*, and *outcomes*. Monographs, textbooks, and review articles were also consulted. Studies not directly pertaining to aneurismal subarachnoid hemorrhage or not written in English were excluded from further evaluation.

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Expert Consensus
Weighting According to a Rating Scheme (Scheme Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Data Quality Classification

Class I: Randomized controlled trial without significant limitations or meta-analysis

Class II: Randomized controlled trial with important limitations (e.g., methodological flaws, inconsistent results); observational study (e.g., cohort, case control)

Class III: Qualitative study, case study, or series

Class IV: Evidence from reports of expert committees and/or expert opinion of the guideline panel, standards of care, and clinical protocols that have been identified

METHODS USED TO ANALYZE THE EVIDENCE

Review of Published Meta-Analyses
Systematic Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

The Clinical Practice Guidelines and recommendations for practice are established based upon the evaluation of the available evidence.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Levels of Recommendation

Level 1: Recommendations are supported by class I evidence.

Level 2: Recommendations are supported by class II evidence.

Level 3: Recommendations are supported by class III and class IV evidence.

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

External Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Blinded external peer review was performed using established criteria for evaluation.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

The data quality classifications (**I-IV**) supporting the recommendations and levels of recommendation (**Level 1-3**) are defined at the end of the "Major Recommendations" field.

Immediate attention is warranted at the time of an aneurysmal subarachnoid hemorrhage (aSAH) rupture as a delay in treatment will adversely affect outcome (**Level 2**; Kowalski et al., 2004; Lorenzi et al., 2003). For signs and symptoms of and diagnostic studies for aSAH, refer to the original guideline document.

Patient Care

Preaneurysm Securement

Assessment

Upon admission of the patient to the intensive care unit (ICU), hourly neurologic exam checks (including a complete neurologic exam, National Institutes of Health Stroke Scale, Glasgow Coma Scale, and hemodynamic monitoring) are performed and compared to baseline to detect early deterioration because of aneurysmal rebleed, acute hydrocephalus, ischemia related to inadequate cerebral perfusion (from early cerebral vasospasm or other causes), or other medical complications.

Airway and Oxygenation

Intubation and mechanical ventilation may be indicated for patients with decreased mental status, compromised airways, or acute lung injuries from subarachnoid hemorrhage (SAH; e.g., neurogenic pulmonary edema), aspiration, or a Glasgow Coma Scale motor score of *withdrawal*. Modes of ventilation vary, especially in patients who have pulmonary complications following SAH. The goal is to maintain adequate oxygenation and ventilation without compromising both intracranial and cerebral perfusion pressures. Positive end-expiratory pressure of 5 cm H_20 may be used cautiously in the aSAH patient; however, it does decrease blood pressure (BP) and may lead to cerebral ischemia (**Level 2;** Muench et al., 2005). Pressure-controlled ventilation should be considered if the patient has significant aspiration or early acute respiratory distress syndrome.

Patients recovering from aSAH are critically ill patients at risk for many common secondary injuries such as atelectasis and pneumonia. Hourly monitoring of breath sounds and frequent deep breathing should be encouraged. Coughing is discouraged in the SAH patient before aneurysm securement because of the increased risk of aneurysm rupture with the increased intracranial pressure (ICP) and BP that occurs during coughing.

BP Management

The exact relationship between aneurysmal rebleed and BP remains to be identified; however, most clinicians agree that to prevent rebleed, BP control is achieved before aneurysm securement. Systolic BP is kept between 90 and 140 mm Hg before aneurysm securement (**Level 3**; Suarez et al., 2006). There are a variety of vasoactive agents used to maintain BP within an acceptable range. Choice of vasoactive agent and BP target range varies depending upon institutional policy (i.e., policy and procedures) and managing clinician preference. Some institutions require clinicians to follow systolic BP, and other institutions follow mean arterial pressure. Typically, BP is maintained within the target range using an initial bolus followed by commencement of an intravenous (IV) drip that is titrated to maintain BP within the target range (**Level 2**; Kraus, Metzler, & Coplin, 2002). Use of sublingual agents that may cause a rapid drop in BP is not recommended. BP should be lowered in a controlled manner as a sudden drop in BP increases the risk of cerebral ischemia.

Hypotension occurring before aneurysm securement places the patient recovering from aSAH at risk for ischemia. Hypotension should be treated with rapid IV fluid replacement beginning with isotonic saline (0.9%) and colloids as necessary. For persistent hypotension, IV vasopressors should be instituted.

Intracranial Pressure Monitoring

When a patient shows symptoms of increasing ICP, or is at increased risk of increased ICP because of large blood load, an external ventricular catheter or subarachnoid bolt is inserted. This can be done in the operating room (during surgical clipping or as a separate surgical procedure) or emergently at the bedside to decrease ICP. Poor clinical grade on admission, acute neurologic deterioration, or progressive enlargement of ventricles on CT scan are clear indications for the use of an external ventricular device (**Level 2**; Mayberg et al., 1994; Rordorf et at., 1997; Suzuki et al., 2000). Newer data suggest that external ventricular drainage does not include likelihood of aneurysm rehemorrhage when drainage is performed at moderate pressures (<10 cm H_2O; **Level 2**; Fountas et al., 2006). Aseptic technique is essential during external ventricular drain or subarachnoid bolt insertion because an infection can occur, especially if the drain is left in for an extended period of time. Cultures are to be routinely performed, and antibiotics are initiated if any signs of infection are present. Some clinicians and institutions use prophylactic antibiotics for aSAH patients with an external ventricular drain, although there is no literature supporting this practice.

Although all of these catheters allow monitoring of ICP, the external ventricular catheter permits cerebral spinal fluid (CSF) drainage to control ICP and clear blood from the CSF. The external ventricular catheter is associated with a higher infection rate than other catheters (**Level 2**; Lozier et al., 2002). Care related to CSF management varies by institution and clinician preference. Continuous drainage of CSF from an external ventricular drain (EVD) at a specified level (above the external auditory meatus or foramen of Monroe as per institutional policy) prevents ICP from rising above that level and allows for continuous clearance of bloody CSF from the ventricles and subarachnoid space (see *Guide to the Care of the Patient with Intracranial Pressure Monitoring: AANN Reference Series for Clinical Practice*).

Fever Management

In febrile patients (temperature >38.3 degrees C or as per institutional policy), fever reduction should be achieved with administration of acetaminophen every 4–6 hours to achieve normothermia (**Level 3**; Suarez et al., 2006). Surface or intravascular cooling is instituted to maintain temperature <38.3 degrees C if medications are not effective (**Level 3**; Suarez et al., 2006). It is important to control fever in this population as it is associated with poorer recovery from aSAH (**Level 2**; Commichau, Scarmeas, & Mayer, 2003; Fernandez et al., 2007). Surveillance cultures may be obtained daily in patients receiving cooling therapy, otherwise cultures should be obtained per Society of Critical Care Medicine guidelines (**Level 3**; O'Grady et al., 1998). In patients receiving surface cooling, monitor and treat shivering with warm compresses to the hands and sedation or paralytics as needed.

Laboratory Data

Initial laboratory data provides clinicians with additional baseline data regarding the patient's medical condition and may help in identification of comorbid conditions. Because complications, including cardiac, pulmonary, and fluid and electrolyte imbalances, are known to arise from the moment of aneurysmal rupture, it is imperative to monitor the overall status of the patient.

Initial laboratory data include the following:

- Basic metabolic chemistry and electrolytes
- Cardiac troponin, creatine phosphokinase (CPK) isoenzymes
- Coagulation studies
- Complete blood count
- Type and screen
- Urine toxicology and chemistry

Arterial blood gases are ordered upon admission and as necessary for intubated patients or those in respiratory distress. Admission testing also includes a 12-lead electrocardiogram and a chest x-ray.

Intravenous Fluids

The goal is to maintain euvolemia (central venous pressure [CVP] 5–8 mm Hg) in the patient recovering from aSAH (**Level 3**; Suarez et al., 2006). Normal saline may be infused at rates between 80 and 100 cc/hr (2–3 L of 0.9% NaCl per 24 hours; **Level 3**; Mayer et al., 2005). Avoid fluid restriction for patients with hyponatremia due to cerebral salt wasting because it has been associated with increased cerebral infarction (**Level 2**; Wijdicks et al., 1985).

Nutrition

Patients should not be given medications by mouth at this time if preoperative, stuporous, or comatose. Parenteral nutrition via continuous infusion is started on day 2 after hemorrhage (**Level 3**; Suarez et al., 2006) if the patient is unable to eat or tolerate enteral feedings. If the patient is not preoperative, stuporous, or

comatose, advancing the diet as tolerated is ideal (**Level 3;** Suarez et al., 2006). A consult to a speech pathologist to evaluate swallowing capability and aid in diet-type selection is recommended for any patient whose ability to swallow is in question.

Although there is significant ongoing research to identify ideal glycemic control in ICU populations, no specific guidelines are routinely applied to the aSAH population. Hyperglycemia has been found to be associated with increased risk of morbidity and mortality following aSAH; therefore, serum glucose should be kept within the range of 80–120 mg/dL with insulin infusion if necessary (**Level 3**; Suarez et al., 2006).

Activity

Typically, activity is limited in patients with an unsecured aneurysm. All activities that increase BP (and, therefore, ICP) are limited to prevent rebleed. The patient should be maintained in a quiet environment with limited visitors until after aneurysm securement (**Level 3**; Suarez et al., 2006).

Deep Vein Thrombosis Prophylaxis

Because of limited mobility, patients with an unsecured aneurysm are at risk for deep vein thrombosis (DVT). In these patients, thigh-high stockings and pneumatic (sequential) compression devices should be implemented as soon as possible (**Level 3**; Suarez et al., 2006). Anticoagulants (e.g., heparin) should be avoided until after aneurysm securement **(Level 3**; Suarez et al., 2006).

Medications

Seizure Prophylaxis

Seizure prophylaxis is maintained during the entire preaneurysm securement phase because of increased risk of aneurysm rebleed associated with seizures. Seizure prophylaxis should be discontinued 2–3 days after aneurysm securement unless the patient has seized or is unstable. In higher-grade patients, anticonvulsants may be continued until ICU discharge (**Level 2**; Chumnanvej, Dunn, & Kim, 2007).

Controversy exists on the need for and length of anticonvulsant therapy in patients without a history of seizures because some anticonvulsants have been associated with poor outcomes, and the percentage of aSAH patients developing seizures is small (**Level 2**; Naidech et al., 2005). If using anticonvulsants, use those that do not change the level of consciousness.

Stool Softeners

Stool softeners are initiated. The patient with an unsecured aneurysm should not strain to have a bowel movement, and stool softeners maintain soft stool so straining is not required (**Level 3**). For patients able to take oral nutrition, a high-fiber diet is instituted. For patients on parenteral nutrition, a high-fiber feeding is instituted.

Pain Management

Headache pain is usually intense after aSAH. Analgesics are administered as needed for pain. Pain causes increased BP, heart rate, and anxiety. All of these can increase risk for aneurismal rebleed and, therefore, must be treated (**Level 3**). Use short-acting and reversible medications when possible.

Sedatives

Agitation can lead to increases in activity, dislodging of catheters, and aneurysmal rebleed. Sedation is administered as needed to patients who are agitated. A short-acting sedative should be used to facilitate frequent neurologic exams free of sedatives. It is not always possible to obtain a neurologic exam free of sedatives, but use of short-acting sedatives increases this likelihood.

Antiemetics

Prevention and treatment of nausea and vomiting are also important for the aSAH patient, both before and after aneurysm securement, especially during the first 24 hours. Vomiting increases ICP and can cause aneurismal rebleed. Patients with nausea should receive an antiemetic routinely.

Gastrointestinal Hemorrhage Prophylaxis

Histamine-receptor antagonists or proton pump inhibitors are instituted to prevent ulcer formation and gastrointestinal hemorrhage.

Psychosocial

Alleviate anxiety by explaining procedures and ICU routine to patients and families. Incorporate a multidisciplinary approach, including pastoral care and social work, to address the patients' needs.

Postaneurysm Securement

aSAH Patient in the ICU

After the aneurysm has been secured, many of the previous care guidelines are maintained; however, some adjustments should be made.

Assessment

Typically, monitoring of neurologic exam and vital signs are performed every hour after surgery or embolization. If the patient remains stable, exam and vital-sign assessment are decreased to every 2 hours and as necessary. Serial complete neurological assessment, including level of consciousness, cranial nerve assessment, and motor exam performed at the bedside, detects subtle changes from the patient's baseline status. Any changes in neurologic exam are reported to the attending physician, resident, or nurse practitioner immediately. Initial assessment will identify changes related to surgery or possible rebleeding of the aneurysm, cerebral edema, or increasing ICP. Continued assessment is vital to

optimize outcomes in this population because cerebral vasospasm is a common secondary sequelae to aSAH and develops very suddenly. Prompt identification of changes in neurologic exam initiates further testing to determine cause of the change and intervention, thereby preventing long-term damage to the brain.

Airway and Oxygenation

For patients who do not require intubation and mechanical ventilation, frequent assessment of airway patency and oxygenation continue. Along with hourly vital-sign assessment, breath sounds are auscultated. Any changes in breath sounds should be reported to the attending physician, resident, or nurse practitioner immediately. Proper oxygenation is necessary to prevent hypoxia and cerebral ischemia. Suctioning may be performed as needed for short intervals with appropriate hyperoxygenation provided prior to suctioning in a patient recovering from aSAH after the aneurysm has been secured.

BP Management

When the aneurysm is secure, an increase in BP is permitted. Maintaining the systolic pressure at less than 200 mm Hg has been recommended (**Level 3**; Suarez, et al., 2006). The target range for ideal BP after aneurysm securement has not been thoroughly defined; however, the goal of BP management is to maintain perfusion of brain tissue and prevent ischemia.

ICP Monitoring

In many patients recovering from aSAH, ICP monitoring will continue after securement of the aneurysm. Any patient at risk for increased ICP should have continued ICP monitoring. Prolonged elevations in ICP are associated with decreased cerebral perfusion pressure and increase the risk of cerebral ischemia and poor outcome (**Level 2**; Mayberg et al., 1994; Rordorf et al., 1997; Suzuki et al., 2000).

Fever Management

In febrile patients (temperature =38.3 degrees C or as per institutional policy), fever reduction is achieved with administration of acetaminophen every 4–6 hours to achieve normothermia (**Level 3**; Suarez et al., 2006). Surface or intravascular cooling is instituted to maintain temperature <38.3 degrees C if medications are not effective (**Level 2**; Badjatia et al., 2004). It is important to control fever in this population because it is associated with poorer recovery from aSAH (**Level 2**; Commichau, Scarmeas, & Mayer, 2003; Fernandez et al., 2007). Surveillance cultures are obtained daily in patients receiving cooling therapy, otherwise cultures should be obtained per Society of Critical Care Medicine guidelines (**Level 3**; O'Grady et al., 1998). In patients receiving surface cooling, monitor and treat shivering with warm compresses, circulating warm air, sedation, or paralytics as needed (**Level 2**; Badjatia et al., 2004).

Laboratory Data

The following laboratory values should be obtained daily after the aneurysm has been secured:

- Electrolytes (including magnesium)
- Troponin, CPK isoenzymes (for the first 5 days after hemorrhage)
- Echocardiogram

Also consider arterial blood gases, chest x-ray, and anticonvulsant levels as needed.

IV Fluids

IV fluids are maintained to assure adequate hydration. In patients with symptomatic vasospasm, triple H therapy (hypervolemia, hypertension, and hemodilution) remains a frequently used regimen in the prevention of cerebral vasospasm after aSAH. Triple H therapy prevents ischemic deficits in patients with mild to moderate symptomatic cerebral vasospasm by augmenting circulating blood flow and perfusion pressures, increasing cardiac output, improving rheology of blood flow, and increasing collateral circulation (Awad et al., 1987; Kassell et al., 1982; Muizelaar & Becker, 1986). The most common symptoms of symptomatic vasospasm are focal ischemic deficits, reflecting the region experiencing ischemia; focal ischemic deficits are often referred to as delayed ischemic deficits because of the temporal establishment. These patients require more aggressive volume expansion and hypertension. The goal of triple H therapy is to achieve CVP 8–12 mm Hg, hematocrit <30, systolic BP =180 mm Hg, and urine output =250 mL/hr. These goals can be achieved by infusing large amounts of colloid or crystalloid or through pharmacologic interventions (**Level 2**; Awad et al., 1987; Janjua & Mayer, 2003; Kassell et al., 1982; Muizelaar & Becker, 1986). Vigilant monitoring of patients is warranted because triple H therapy includes complications such as myocardial injury, pulmonary edema, hyponatremia, cerebral edema, and bleeding of unsecured aneurysm (Awad et al., 1987; Janjua & Mayer, 1982; Mocco et al., 2006; Muizelaar & Becker, 1986; Solomon, Fink, & Lennihan, 1988; Treggiari-Venzi, Suter, & Romand, 2001). Although not yet used as a standard of care in all facilities, invasive monitoring, such as a pulmonary artery catheter, is warranted in patients with cardiac dysfunction to adequately monitor and treat the patient recovering from an aSAH (**Level 3**; Mayer et al., 2005; Suarez et al., 2006). See Figure 7 in the original guideline document for an angiogram showing cerebral vasospasm before and after treatment.

Nutrition

Patients recovering from aSAH are evaluated by a speech therapist to assure adequate swallowing reflex before being allowed to take food or fluids orally. After it has been determined that swallowing is normal, the patients' usual diet with increased fiber may be followed. Patients with impaired swallowing should have a diet prescribed by the speech therapist to prevent aspiration.

Activity

After the aneurysm has been secured, patients gradually increase activity. Physical and occupational therapists are consulted postoperatively when patients are stable.

DVT Prophylaxis

Thigh-high stockings and pneumatic (sequential) compression devices are maintained postaneurysm securement (**Level 3**; Suarez et al., 2006). When the aneurysm has been secured, heparin therapy for prevention of DVT may be considered. Additional factors, such as future need for surgery or angiography, are weighed into the decision to institute heparin therapy.

Medications

- Anticonvulsants—If seizures have occurred or the patient is at higher risk for seizure development, prophylaxis is maintained. If using anticonvulsants, use those that do not change the level of consciousness.
- Stool softeners—Stool softeners should be continued because narcotics, other medications, and decreased physical mobility and bowel motility may cause constipation.
- Sedation—Sedation may be warranted particularly in patients who are intubated, have ICP monitors and central lines, or both.
- Antiemetics—Use of antiemetics may be continued as needed.
- Cerebral edema treatment—In patients with cerebral edema, 2% or 3% hypertonic saline may be administered at a rate of 75–150 cc/hr unless contraindicated (**Level 2**; Suarez et al., 1999). Frequent electrolyte monitoring is indicated at least every 6 hours. Monitor and replace potassium to maintain normal levels. Monitor serum sodium to a goal of 145–155 meq/L and serum osmolarity 300–320 mOsm/L levels. Notify the provider on call if the serum sodium is >155 meq/L. Hypertonic saline therapy can be tapered slowly if no longer indicated (i.e., improving mental status or cerebral edema or the serum sodium rises to dangerous levels >155 meq/L; **Level 2**; Suarez et al., 1999).
- BP treatment—A variety of pharmacological agents may be used to maintain BP within the target range. See section on "BP Treatment" above for treatment of BP.
- Calcium channel blockers—Nimodipine (Nimotop), a calcium channel blocker, is the only drug currently approved by the Food and Drug Administration for the prevention and treatment of vasospasm following aSAH. Nimodipine crosses the blood–brain barrier and inhibits calcium entry into cells, subsequently reducing the contractile state of the vascular smooth muscle. It is indicated to reduce the incidence and severity of delayed ischemic deficits from vasospasm following aSAH and has been shown to improve outcomes following aSAH despite a lack of evidence of arteriographic efficacy (**Level 1**; Allen et al., 1983; Neil-Dwyer et al., 1987; Petruk et al., 1988; Philippon et al., 1986; Pickard et al., 1989). Solomon and colleagues (1988) proposed that the improved outcome with nimodipine was related to it inhibiting calcium entry into ischemic neurons, thereby increasing viability of these cells. Oral or enteral administration of 60 mg of nimodipine every 4 hours is instituted within 96 hours after hemorrhage and continued for up to 21 days.

Other Tests and Treatments

Several tests are used to monitor for presence of cerebral vasospasm. Transcranial Doppler (TCD) ultrasonography uses ultrasound waves projected through a thin spot in the skull to the cerebral blood vessels. The ultrasound

waves bounce off of the red blood cells (RBCs) as they flow through the cerebral blood vessel. A decrease in the internal lumen of the blood vessel requires the blood (and hence, the RBCs) to move at a higher velocity. Although TCD ultrasonography is not sensitive or specific enough to use to diagnose cerebral vasospasm, it is a noninvasive diagnostic tool that can be used in conjunction with neurologic exam and other diagnostic tests to manage the aSAH patient. TCD ultrasonography has several limitations. It is only as good as the technologist performing the exam, so a neurophysiologist should be consulted whenever available. There are multiple physiologic states that will increase blood flow, thereby increasing blood velocity. Independent of neurologic exam, TCD can consistently measure middle cerebral artery (MCA) mean velocities and can detect increasing mean MCA velocities. MCA flow velocities <120 cm/sec and >200 cm/sec respectively have a strong negative and positive predictive power for determining which patients will develop ischemic deficits (**Level 3**; Aaslid, Huber, & Nornes, 1984). Some clinicians and institutions prefer to monitor patients using the Lindegaard index. The Lindegaard index was developed to predict cerebral vasospasm using TCD. It is calculated as *mean MCA velocity/mean internal carotid artery (ICA) velocity*.

A Lindegaard index = 3 is indicative of MCA vasospasm and =6 as severe vasospasm (**Level 2**; Aaslid, Huber, & Nornes, 1984; Lee et al., 1997; Lindegaard et al., 1988). TCD velocity associated with a decrease in neurological function, or independently in comatose patients, can be used as a preliminary screening method to identify patients requiring further intervention (i.e., CT scan or cerebral angiogram).

Cerebral angiography is the gold standard for diagnosing cerebral vasospasm. The procedure is the same as described on pages 12 & 13 in the original guideline document for aneurysm identification. The angiogram provides a clear visualization of the cerebral blood vessels, and a decrease in lumen size is indicative of cerebral vasospasm. Variation in the decrease in lumen size also quantifies severity of cerebral vasospasm. A blood vessel with a significant decrease in lumen size requires intervention.

In patients with symptomatic vasospasm, it is often managed with triple H therapy. More severe symptomatic vasospasm requires more aggressive treatment. Endovascular therapies for refractory vasospasm include both intraarterial vasodilators and mechanical dilatation of vessels with balloon angioplasty. The determination of which of these therapies to use is an individual decision and depends upon the patient's general health and severity of vasospasm. Papaverine is a widely used agent (Fandino et al., 1998; Kaku et al., 1992; Polin et al., 1998; Sawada et al., 1997), although, there is preliminary evidence that verapamil (Feng et al., 2002), nicardipine (Kasuya et al., 2005; Kasuya et al., 2002), nimodipine (Biondi et al., 2004; Hui & Lau, 2005; Tanaka et al., 1982), and fasudil hydrochloride (Tachibana et al., 1999; Tanaka et al., 2005) may be of benefit (**Level 2**). A review of intraarterial treatment of cerebral vasospasm and mechanisms of action of these drugs was provided by Sayama, Liu, and Couldwell (2006).

For patients at risk for or with known cerebral vasospasm, more aggressive treatment should be used. Patients without symptoms but with elevated TCD velocities or CT evidence of diffuse cerebral vasospasm require at least a central

venous catheter, repletion with crystalloids, and the above end points for volume resuscitation (CVP =8 and urine output =250 mL/hr). CVP monitoring is indicated at least every 2 hours. Treatment with fluid or albumin bolus to keep CVP >5 for normovolemia or CVP >8 mm Hg for hypervolemia is indicated (**Level 3**; Mayer et al., 2005; Suarez et al., 2006). Hypervolemia is desirable in patients without underlying cardiac disease to maintain adequate cerebral perfusion pressure (**Level 3**; Mayer et al., 2005). Antihypertensive and diuretic agents should be avoided (**Level 3**; Mayer et al., 2005).

For patients with a secured aneurysm and clinical evidence of cerebral vasospasm, more aggressive therapy is instituted. If not yet performed, cerebral angiography may be performed to accurately diagnose and treat cerebral vasospasm (see above for angiographic treatment of cerebral vasospasm). Pulmonary pressure monitoring may be indicated in patients with cardiac dysfunction with the goal of maintaining pulmonary artery wedge pressure >12 mm Hg and cardiac index >4.0 L/min (Mayer et al., 2005). If desired effect is not attained, cerebral angiography for angioplasty or drug infusion may be undertaken if qualified personnel are available (see above and page 12 in the original guideline document for angiographic treatment).

Patient Monitoring in the ICU

Neurological

- Frequent neurological assessment is indicated with a minimum of at least every hour or more frequently when patients are actively ischemic.
- For patients with external ventricular drain or subarachnoid bolt, see *Guide to the Care of the Patient with Intracranial Pressure Monitoring: AANN Reference Series for Clinical Practice*.
- Monitor TCD values including systolic velocities, mean velocities, and Lindegaard ratio and compare them to baseline and previous values. Discuss elevations (mean MCA velocity >120 mm Hg or Lindegaard ratio =3) with attending physician, resident, or nurse practitioner promptly.
- Electroencephalography (EEG) is commonly used to monitor for seizure activity in many patients with neurological conditions. Continuous EEG is used to monitor patients with unexplained neurological deterioration to detect nonconvulsive seizures by providing information about global cerebral activity and cortical function (Wartenberg et al., 2006). Electrodes are placed at distinct positions around the skull, and brain activity is monitored. Typical brain activity shows much variation in the brain waves, while seizure activity is evidenced by rhythmic waves indicating neurons firing in unison. In patients with continuous EEG, collaborate with the EEG technician to ensure that leads are in place. Monitor for clinical seizures.
- Repeat CT scans and cerebral angiography are common tests used to monitor the patient recovering from aSAH. CT scans are routinely performed postoperatively and postcoiling and are warranted when the patient's clinical exam changes. Cerebral angiography should be obtained postoperatively, postcoiling (to ensure aneurysm obliteration), and when clinical exam or TCDs suggest cerebral vasospasm.

Cardiovascular

- Hemodynamic monitoring is obtained at least every hour or more frequently when titrating vasoactive agents. Monitor peripheral pulses and troponin levels during vasopressor infusion.
- CVP monitoring is indicated at least every 2 hours to keep CVP >5 for normovolemia or CVP >8 mm Hg for hypervolemia (Mayer et al., 2005).
- Pulmonary artery pressure monitoring is indicated in patients with cardiac dysfunction, with pulmonary artery diastolic pressure kept >14 mm Hg or a cardiac index >4.0 L/min (Mayer et al., 2005). Some institutions have incorporated pulmonary artery pressure monitoring as a standard of care for all aSAH patients, although the literature is not clear on the efficacy of this practice.

Respiratory

- In patients requiring mechanical ventilation, frequent arterial blood gases, pulse oximetry (SaO_2) and end tidal carbon dioxide ($ETCO_2$) are indicated. Arterial blood gases should be obtained daily and with each change in ventilator settings. Continuous SaO_2 or $ETCO_2$ monitoring should be incorporated to maintain SaO_2 =90% or $ETCO_2$ =35–37 mm Hg.
- Suctioning should be performed only as necessary to maintain clear lungs and limited to 15 seconds, hyperoxygenating the patient prior to the procedure. Saline lavage prior to suctioning should be avoided.

Gastrointestinal

- Abdominal assessment is indicated at least every shift.
- Nutritional support is obtained via tube feeding if the patient is unable to take orally.

Renal

- Urine output is monitored precisely. A urinary catheter is often warranted to assure accurate monitoring.
- Urine electrolytes and specific gravity should be monitored as these patients are at risk for CSW and the syndrome of inappropriate antidiuretic hormone secretion.
- It is important to be aware that patients receiving triple H therapy often have high urine output.

Integumentary

- In patients on complete bed rest, skin assessment is performed every shift.
- Frequent turning (at least every 2 hours) is performed for patients unable to move themselves.
- Skin-care techniques are performed every shift with the assessment.

Endocrine

Tight glycemic control is to be maintained, using an insulin drip if necessary. Glucose should be monitored at least daily in all patients recovering from aSAH.

In patients requiring an insulin drip, glucose should be evaluated hourly until reaching the target blood glucose (100–120 mg/dL) and then every 2–4 hours.

Psychosocial

Social workers and pastoral personnel are consulted to assist in alleviating concerns of patients and families. Social workers should also collaborate with the critical care team to identify and facilitate appropriate after-discharge care.

Refer to the original guideline document for a brief overview of current research and future therapies of cerebral vasospasm including intravenous magnesium sulfate, statins, and neuromonitoring techniques.

Care of the aSAH Patient in the Neurological Unit

When the patient has stabilized and risk of cerebral vasospasm is low, the patient recovering from aSAH is transferred to the neurological unit. Vital signs with complete neurologic examination should be performed every 4–8 hours. Medications should be maintained as in the ICU setting; however, patients should no longer require intravenous vasoactive medications to maintain BP; mechanical ventilation; or central venous pressure, pulmonary artery, or arterial BP monitoring. If anticonvulsants are being used, they should be continued in the unit. Antiemetics should be used as needed, although nausea and vomiting are not common in patients stable enough for transfer to the unit. Pain medications should be continued as needed. Nimodipine should be ordered at the same dose of 60 mg orally every 4 hours until 14–21 days after hemorrhage. Activity should be increased as tolerated by the patient. Physical and occupational therapy should be consulted to determine patient functioning and needs for rehabilitation during the remainder of the hospital stay and after discharge.

Care of the aSAH Patient outside the Hospital

Home

Most patients recovering from an aSAH will be discharged to their homes. A family member or significant other should be present when discharge instructions are given to the patient. If the patient is being discharged less than 21 days after hemorrhage, nimodipine should be continued for 14–21 days. Other medications should be continued after discharge. The patient should be instructed to take all medications as ordered. The patient should also be encouraged to drink lots of water and other nonalcoholic liquids to ensure hydration after discharge. Although activity is not restricted after discharge, patients should be advised to monitor themselves for tiring and exhaustion and to schedule activities accordingly. Referral to outpatient physical therapy is recommended to ensure maximal recovery.

Rehabilitation

Some patients recovering from an aSAH will be discharged to a rehabilitation center for more intensive physical and occupational therapy. Medications should be continued after discharge. Nimodipine should be continued for 21 days after

hemorrhage. In the rehabilitation setting, intake and output should be monitored closely to prevent dehydration.

Patient and Family Education

For the SAH patient, education may not be possible immediately upon admission to the hospital. In many cases, the patient is too ill or has too low of a level of consciousness to benefit from education. However, when the patient is awake enough, education by the health professionals should begin immediately.

Because of the severity of subarachnoid hemorrhage, education usually focuses on the family members. It is normal for the family to be overwhelmed and have many questions. Because of the stress that the family members experience, many times education must be repeated and reinforced until the family members can process this information.

The brain may take 6–15 months to recover to the fullest ability (Haug et al., 2007; Samra et al., 2007). It is quite common for headaches to last up to 6 months or longer. The family also must be educated on the symptoms of another stroke. These symptoms include, but are not limited to, severe headache, sudden speech difficulties, sudden vision change, inability to move one side of the body, and numbness or tingling on one side of the body. The patient should call emergency services if any of these symptoms appear.

Although there is no literature supporting the screening of family members of aSAH patients for aneurysms, some physicians refer first-degree relatives for magnetic resonance imaging (MRI), magnetic resonance angiography, computed tomography (CT) angiography, or angiography for cerebral aneurysms. The family members considered at risk and the technique used for screening are currently based on physician preference.

The American Stroke Association (www.strokeassociation.org) and the National Stroke Association (www.stroke.org) have excellent Web sites that can be resources for nurses, patients, and family members. Another resource that is excellent for education of the family is a booklet titled *Brain Aneurysm: Understanding Care and Recovery*. This booklet is distributed by Krames and may be ordered by calling 800/333-3032. This booklet is also endorsed by the American Association of Neuroscience Nurses.

Key areas of patient, family, and caretaker education in the subarachnoid hemorrhage population are as follows:

- What is a brain aneurysm?
- What is a subarachnoid hemorrhage?
- Signs and symptoms of a ruptured aneurysm
- What is hydrocephalus?
- What is cerebral vasospasm?
- Possible medical procedures that the patient may encounter while in the hospital
    - CT scan
    - Lumbar puncture
    - Arteriogram/angiography

    - TCD ultrasonography
    - MRI
- Treatment options
    - Clipping of aneurysm via craniotomy
    - Endovascular procedures (coiling)
- Length of hospital stay
    - ICU stay (average 10–14 days)
    - Step-down/unit stay (average 5–7 days)
- Common complications are as follows:
    - Cerebral vasospasm
    - Hydrocephalus
    - Hyponatremia
    - Loss of short-term memory
    - Behavior changes
    - Seizures
    - Depression
    - Dysphagia
    - Skin breakdown
    - Urinary/bowel incontinence
- After the hospital
    - Inpatient rehabilitation
    - Long-term nursing care
    - Recovery/prognosis
- Screening of first-degree relatives

Documentation

Documentation is similar to the documentation for the ischemic stroke patient. Documentation should include the following:

- Time of onset
- Symptoms
- Neurological assessment: level of physical functioning, cognitive level, muscle strength, and cranial nerve findings. (Some providers prefer the nurse to describe "what they saw" versus saying that a certain cranial nerve is not functioning.)
- Vital signs: BP, pulse rate and rhythm, respirations, oxygen saturation, temperature, blood glucose, CVP, ICP (if patient has an EVD), cardiac output (if patient has a Swan-Ganz catheter)
- Input and output
- Swallowing ability
- Mechanism of communication
- Activity level
- Skin integrity
- Psychosocial issues
- Patient and family education
- Discharge planning

Definitions:

Data Quality Classification

Class I: Randomized controlled trial without significant limitations or meta-analysis

Class II: Randomized controlled trial with important limitations (e.g., methodological flaws, inconsistent results); observational study (e.g., cohort, case control)

Class III: Qualitative study, case study, or series

Class IV: Evidence from reports of expert committees and/or expert opinion of the guideline panel, standards of care, and clinical protocols that have been identified

Levels of Recommendation

Level 1: Recommendations are supported by class I evidence.

Level 2: Recommendations are supported by class II evidence.

Level 3: Recommendations are supported by class III and class IV evidence.

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

REFERENCES SUPPORTING THE RECOMMENDATIONS

References open in a new window

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of supporting evidence is identified and graded for selected recommendations (see the "Major Recommendations" field).

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Maximization of recovery for from aneurysmal subarachnoid hemorrhage (aSAH)
- Appropriate patient monitoring and management of care to prevent secondary injury thereby improving outcomes

POTENTIAL HARMS

- The external ventricular catheter is associated with a higher infection rate than other catheters.

- Cerebral angiography is an invasive procedure with a small but significant risk of complications, including perforation of the vasculature and hemorrhage from the catheter insertion site.
- Triple H therapy (hypervolemia, hypertension, and hemodilution) includes complications such as myocardial injury, pulmonary edema, hyponatremia, cerebral edema, and bleeding of unsecured aneurysm.
- Controversy exists on the need for and length of anticonvulsant therapy in patients without a history of seizures because some anticonvulsants have been associated with poor outcomes, and the percentage of aneurysmal subarachnoid hemorrhage patients developing seizures is small.

CONTRAINDICATIONS

CONTRAINDICATIONS

Lumbar puncture is contraindicated in the presence of mass effect, obvious intracranial bleed, and in cases where there is an increase in intracranial pressure because of the risk of potential herniation.

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

- The authors, editors, and publisher of this document neither represent nor guarantee that the practices described herein will, if followed, ensure safe and effective patient care. The authors, editors, and publisher further assume no liability or responsibility in connection with any information or recommendations contained in this document. These recommendations reflect the American Association of Neuroscience Nurses' judgment regarding the state of general knowledge and practice in their field as of the date of publication and are subject to change based on the availability of new scientific information.
- This reference is an essential resource for neuroscience nurses responsible for the care of this patient population with a multitude of biopsychosocial needs. This guide is not intended to replace formal learning, but rather to augment the knowledge base of clinicians and provide a readily available reference tool.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better

IOM DOMAIN

Effectiveness
Patient-centeredness
Timeliness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

American Association of Neuroscience Nurses. Care of the patient with aneurysmal subarachnoid hemorrhage. Glenview (IL): American Association of Neuroscience Nurses; 2007. 30 p. [140 references]

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FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

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GUIDELINE STATUS

This is the current release of the guideline.

GUIDELINE AVAILABILITY

Electronic copies: Available from the American Association of Neuroscience Nurses Web site.

Print copies: Available from the American Association of Neuroscience Nurses, 4700 W. Lake Ave., Glenview, IL 60025.

AVAILABILITY OF COMPANION DOCUMENTS

None available

PATIENT RESOURCES

None available

NGC STATUS

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